Claims

1. A method for determining significant bone density losses, wherein measurement values of real or mathematically simulated bone density loss processes, which are present in electronic storage media and, as a function of time, reflect laboratory parameters of practically or theoretically known clinical signs and symptoms, are used as reference values for the process, and bone marker values of serum or urine samples, associated with bone density losses and measured by common laboratory techniques, are determined by sample preparation steps such as

- treating with antibodies
- incubation steps
- separation procedures
- using analytical techniques

and recorded over an input mask in an electronic data memory, are used for determining significant bone density losses,

a) at the time of the analysis, all N available patient-related data being copied from the data memory over an interrogation function and made available for the further processing (measured values M (t_n; k) of the K in the laboratory of the bone marker, determined after step x of the process at times t_1 ... t_n)

b) the measured values of the bone markers with respect to the first line in the Table being normalized according to the equation

$$M^*(t_n;k) = \frac{M(t_n;k) - M(t_1;k)}{M(t_1;k)} \qquad k = 1,...,K; \quad n = 1,...,N$$

and the measurements as a function of time being converted into months,

c) the normalized measured value being converted into a scalar quantity D(t_n) for the graduated description of the course of the bone density, the equation

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$$D(t_n) = \sqrt{\sum_{k=1}^{K} Wk \cdot \left(M^*(t_n;k)\right)^2}$$

being used for the graduated description of the course of the relationship

d)   from the evaluations of the progress determined, evaluations of the progress for those time sections of

$$D^*(t) = \frac{(t_n - t) \cdot D(n-1) + (t - t_{n-1}) \cdot D(n)}{t_n - t_{n-1}} \quad , t_\in \left[t_{n-1}, t_n\right]$$

being calculated by interpolation, for which reference values are available,

e)   from the interpolated evaluations of the progress, similarity dimensions being calculated, the function

$$A_j(t) = \sum_{m=1}^{M} \frac{t_m}{t_M} \cdot V_m \cdot \left(R_j(t_m - D^*(t_m)\right)^2$$

being used to calculate a similarity dimension between the data, which is to be investigated, and all the reference values, available in the database and, at the same time, similarity dimensions to the reference values and to the time in months being found,

f)   from the similarity dimensions for all reference values, those reference values being determined, which have a high similarity in the mathematical sense, such as the

greatest similarity: $A^* = \min_{j=1...J} \{A_j\}$

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positive alternative (+) $\quad A^+ = \min\limits_{j=1,\dots,J, A_j \neq A^*, R_j(t_N) > D(t_N)} \{A_j\}$

negative alternative (-) $\quad A^- = \min\limits_{j=1,\dots,J, A_j \neq A^*, R_j(t_N) < D(t_N)} \{A_j\}$

with subsequent output of the type description as text component for describing the situation;

g) the prediction being derived from these three reference values, if $B_1 = A^*$, $B_2 = A^+$, $B_3 = A^-$,

the following expression

$$R(t) = \frac{1}{\sum\limits_{j=1}^{J} B_i} \cdot \sum\limits_{j=1}^{J} \left(\left(\sum\limits_{j=1}^{J} B_i - B_j \right) \cdot R_j(t) \right)$$

being used for the predicted value at time t

h) the degrees of freedom for the specification of the model, given as functional parameters in the functional relation of $D(t_n)$ and $A_j(t)$ being occupied by standard specifications and fitted by statistical analysis of the reference values to practical experience for optimizing the quantitative prediction of the bone density loss;

i) the time being calculated, at which, according to this prediction strategy, the percentage deviation is greater than a specified threshold value, this time being the starting point for planning the scheduling of the next investigation.

2. The method of claim 1, wherein the degrees of freedom, given as function parameters in the functional relationship of $D(t_n)$ and $A_j(t)$, are filled in by

the mathematical method of least squares so that specified sequences are taken into consideration in the best way for reference values.

3. The method of claim 1, wherein reference values are used, which are calculated values from an analytical mathematically assumed course (exponential functions).

4. The method of claim 1, wherein reference values are used, which are empirical values from imaginary, assumed processes.

5. The method of claim 1, wherein reference values are used, which are concrete values from patients with known situations.